ELECTRIC & MUSICAL INDUSTRIES LTD.
RECORDS & INTERNATIONAL DIVISION.
Record Engineering Development Dept.

Ref. REDD.M47.

Line Amplifier Type REDD.47.

Purpose.

This unit is intended as a line voltage amplifier of small dimensions, for use between control networks in a sound mixing and control console. To allow for use under various conditions, a compromise has had to be made between high bridging input impedance, noise level, and frequency response. Three alternative values of effective gain are available, and the unit is capable of an output of 0 dBm under matched conditions, or +6 dBm with low output impedance, into a load of 200 ohms resistive, or it will give an output of 1 volt r.m.s. into open circuit. At these levels, harmonic distortion is very low. The output can be increased to about +14 dBm on overload peaks before severe audible distortion becomes apparent.

Description.

The amplifier consists of two valve stages, resistance capacitance coupled with two loops of negative feedback.

Input Circuit.

The input transformer is designed to have the highest possible step-up ratio attainable in the space available, with very generous hum screening. Increase of ratio by reducing primary turns results in too low a primary inductance, with increase in iron distortion. If the secondary turns are increased, leakage inductance and secondary self-capacitance both increase, and resonate too low in the frequency spectrum, leading to loading effects on the line at high frequencies. Such resonance effect is in fact present, and is damped by the resistor R1 , the loading effect of this resistor being removed at low frequencies by condenser C_{13}.

First Stage.

The first stage consists of an EF.86 pentode operated under conventional conditions. The cathode is not decoupled directly to earth, but to a resistance across which the overall negative feedback voltage is developed. This resistance R5 is kept to the low value of 120 ohms, so that the effect of hum voltages induced in the cathode from the heater is negligible.

The input terminals are connected through the socket S2 and plug P2 as two crossed pairs. Any a.c. magnetic field linking with this input plug induces opposing voltages in the two loops, and considerably reduces hum pick-up at this point.

Output Stage.

The output stage consists of both halves of an E88CC triode connected in parallel, to give low output impedance. The cathode is decoupled to earth for the same reason. This valve is resistance-capacitance coupled to the output transformer, the total loading impedance on the valve being kept as high as possible. The valve is run in a low-voltage, high current condition to provide adequate current swing at the output, and because this condition gives lower distortion.

Feedback.

The output stage distortion is still relatively high, being mainly second harmonic, and negative feedback is therefore applied directly from anode to grid to reduce this distortion to the same order as that in the first stage, also mainly second harmonic. This feedback voltage is developed across the resistor R8 , which also serves to provide an adequate load resistance for the first stage.

Both stages are therefore generating about the same amount of second harmonic distortion, but as their anodes are in antiphase, this second harmonic tends to cancel, and in fact drops to the same order as the third harmonic distortion, higher harmonics being negigible.

To reduce this residual distortion to the required value, overall feedback is applied from the anode of the second stage to the cathode of the first.

Gain Adjustment.

Very little overall feedback is in fact required, but a lot can be tolerated without danger of instability. Variable feedback is therefore used to control the gain, this being applied by switching different values of resistance into the feedback network.

With increased feedback (lower gain) phase shift due to output transformer leakage inductance causes a rise in top response. This is corrected by placing small phase-correcting condensers across the appropriate feedback resistors.

With a 200 ohm load connected between terminals 2/5 and 2/6, the voltage gain measured between input and output terminals is equivalent to 34, 40, or 46 dB, selected by the switch.

Gain Setting.

In order to compensate for small changes in gain due to change of valves, etc., a fine gain setting is provided, using screwdriver adjustment normally protected by a "Nyloc" nut and cover. The arrangement adopted is to shunt the resistor R5 , across which the feedback voltage is developed.

Gain Setting.(Contd).

A carbon variable resistor is to be preferred, as for presets this type is more reliable for contact resistance, smoother in resistance change, and more easily obtained in non-linear grading. However, low value carbon variable resistors are not readily available, and the arrangement shown in the circuit diagram combining a 5k ohms variable resistance with a 240 ohms fixed resistor R_6 has been used.

Supplies.

The heaters of the valves are fed with 6.3 V a.c. at 0.5 amps. H.T. is fed in at between 380 and 400 volts direct from the small reservoir condense: of an external rectifier unit. An additional reservoir condenser is incorporated in the amplifier. Thus when several amplifiers are connected to a common rectifier unit, the total reservoir capacitance increases roughly in proportion to the load current. Provided that the rectifier and transformer internal resistance are small, this results in much improved regulation of t: power supply, and the voltage remains approximately constant, indepen:e:nt of load.

Adequate resistance-capacitance hum filtering is provided, terminating i: a pair of neon stabilisers, which serve the double purpose of stabilising th H.T. voltage against rectifier regulation, and eliminating low-frequency surges due to sudden mains voltage fluctuations ("mains bumps"). The first stage is heavily decoupled.

Provision is made for metering valve feed currents and H.T. voltage on a external meter.

Rumble Filter.

For use in cases where unwanted low-frequency rumble at frequencies belo 30 c/s is present with the signal, a condenser of 1.8 μF capacitance can be connected in series with the input line. This forms, in effect, an imperfec ly terminated half-section filter, in conjunction with the input transformer primary inductance. The result is to give a fairly sharp low-frequency cut-off just below 30 c/s, which may be found useful in certain circumstances.

There is, however, a danger that the "rumble" may contain components of large amplitude at a frequency approximating the resonant frequency of the condenser and inductance. In this event, relatively high magnetising curren may flow in the transformer primary, resulting in iron distortion, with the consequent inter-modulation between signal components, and between signal an rumble.

It is therefore recommended that this device be used only when essential When not required, the condenser may be short-circuited.

Construction.

The unit is housed in a plug-in cassette, measuring approximately 11½" long overall, with front panel 5.3/16" x 2.3/32". All connections are made automatically by means of two 16-way plugs at the rear, when the unit is plugged into a suitable housing, and secured by means of the thumb-screw located on the panel.

Servicing.

Access.

All components are reasonably accessible when the side cover on the lower right-hand side is removed. To remove this cover, slacken, but do not remove, the two screws holding this cover to the front panel. Remove the two screws securing it to the rear panel, and lift off cover.

Valves can be removed in the normal way after removing the bayonet-latched retainers. To extract the neon regulator valves, remove the left hand upper runner by taking out the rear screws and slackening the front. The retainer can then be removed and the regulator valves extracted.

Warning.

DO NOT SWITCH ON THE UNIT WITHOUT THE VOLTAGE REGULATORS, as this may result in excess voltage being applied to the condensers. When the regulator V_3 (L.H.S.) is removed, the H.T. is automatically broken, but it is not practicable to apply this refinement to V_4 (R.H.S.), due to valve pin connections.

E.W.B-J/AV. 22.1.60.

ADDITIONAL NOTES.

Signal-to-Noise Ratio.

The signal-to-noise ratio is extremely good, and the equivalent hum and noise can be taken as equal to or better than -120 dBm referred to the input, when the amplifier is set for maximum gain. The deterioriation when set to the mid-gain position is very slight, but, as might be expected, there is a noticeable (although not serious) worsening at the lowest gain position, at which second stage noise begins to be appreciable. For this reason, the lowest gain position should not be used unless there is a reasonably high input signal.

Gain under Various Conditions.

For an amplifier set to the mid-gain position (40 dB), the working conditions with the rumble filter in and out of circuit, and with the output open circuited, or closed by 200 ohms (as for the test conditions specified), or built out to 200 ohms and matched are shown on Drawing REDD.47/C25.

Connections to McMurdo Sockets.

The normal external connections to the amplifier are shown on Drg. REDD.47/D26.

External Cable Braid Connections.

From the circuit diagram REDD.47/C1/1, it will be seen that, if the braid of the input cable is connected to Socket 2, Pin 2, it will be automatically earthed when the amplifier is plugged in to its carrier frame; also, that if the braid of the output cable is connected to Socket 2, Pins 4 and/or 12, this braid will be earthed automatically when some later amplifier in the system is plugged in.

This facility is not used on equipments on which

(a) it might be dangerous or confusing to lose the cable braid earth when an amplifier is removed, or

(b) on which seperate provision is made for earthing the cable braids by means of linked terminals so as to facilitate servicing should an earthing fault develop.

In these cases, the connections shown on Drg. REDD.47/D26 are used.

Input Impedance and Rumble Filter.

With the rumble filter in circuit, the input impedance is reduced to 3 k ohms at high and medium frequencies. This gives a loading loss of 0.6 dB from a 200 ohm source, and the pre-set gain control should be re-adjusted to give the nominal 46 dB insertion gain at the mid-position of the switch.

Gain Control Switch.

The feedback resistors R13 - R15 were designed for the amplifier with the rumble filter out of circuit. With the rumble filter in circuit, and the voltage gain increased to compensate for this, the nominal 6 dB step from "40" to "46 dB" will be somewhat less than 6 dB. This is of little practical significance, unless two amplifiers are being used for stereo, when, of course, both should have their rumble filters in, or both should have them out.

Pre-Set Gain Control.

The range of the pre-set control is only about 2.6 dB @ "34", 2 dB @ "40", and 1.2 dB @ "46". It has very little effect over the first $\frac{3}{4}$ of its travel.

An alternative circuit, giving somewhat smoother control and a slightly higher maximum gain, is shown on the circuit diagram. Another alternative would be to use a 5 k anti-log pot. in the original circuit, if this type becomes available.

Power Consumption.

Low Tension:-	6.3 V	0.5A	= 3.15 w
High Tension:-	380 V	0.03A	= 11.4 w
			14.55 w

WARNING:-

If the H.T. supply voltage rises, for example, from 380 V to 410 V, the extra 30 volts will be dropped in the three 1 k resistors before the neon stabilisers. This means that the H.T. current will rise from 30 mA to 40 mA, and such a rise, on each of a bank of amplifiers, would bring the power unit on most equipments dangerously close to overload. Under these conditions, care should be taken to <u>see that the mains transformer is correctly strapped</u> for the mains supply voltage, and the additional 1 k resistor <u>R.21 should be brought into circuit if necessary</u>, (See REDD.47/C1/1).

WARNING:-

The reservoir condenser in the amplifier is normally 80 µF and there is a further 44 µF plus the neon tubes closely associated.

On no account should an amplifier be plugged in to a live rack. <u>Switch off the mains and wait for half-a-minute</u>, otherwise the amplifier fuse will blow and there will be a grave danger of sputtering the gold plating on the McMurdo plug and socket.

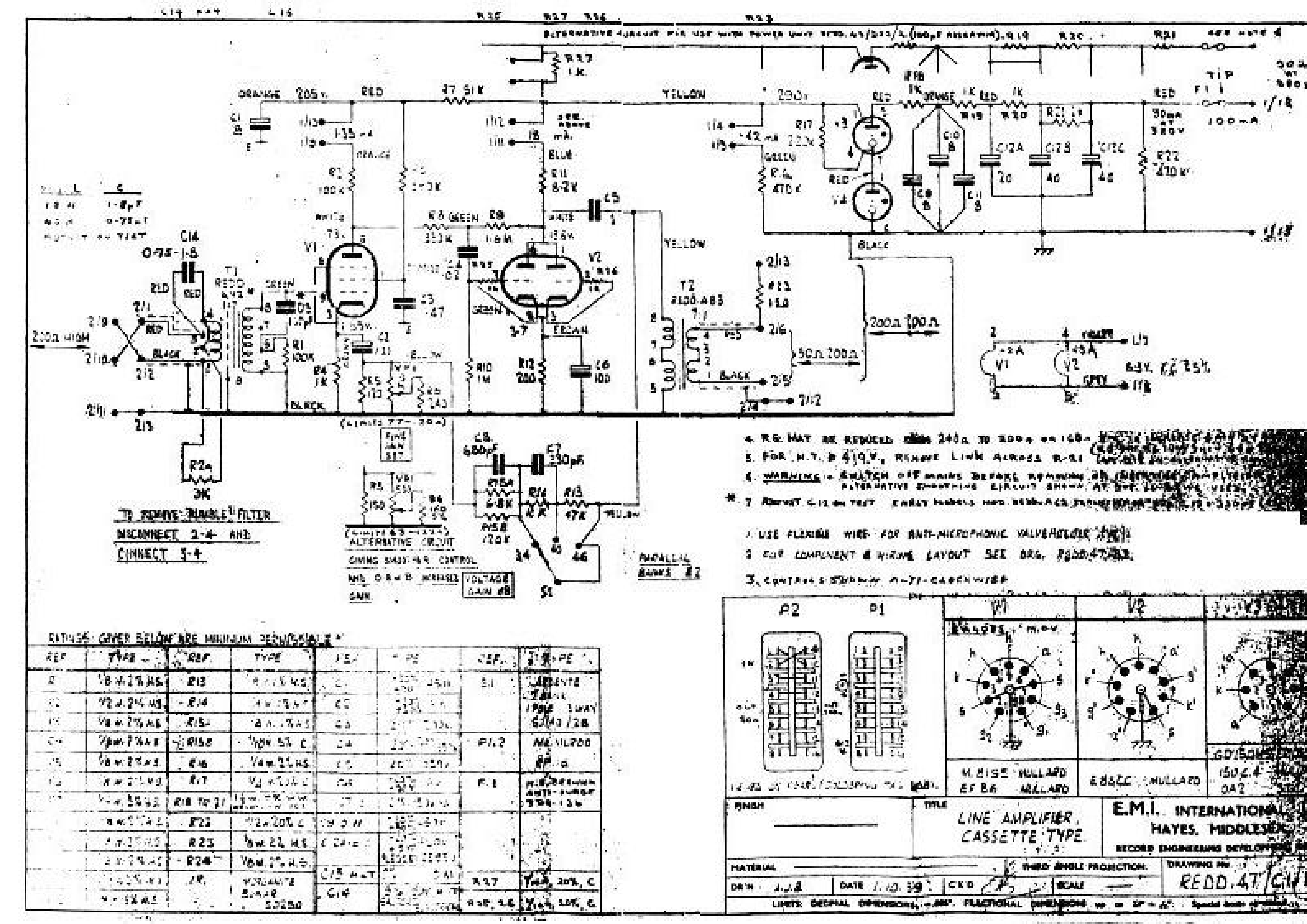
Similarly, <u>switch off and wait for half-a-minute</u> before removing an amplifier, for the above reasons and because of the danger of shock. (Time constant CR = 124 x .470 = 58 seconds).

WARNING:-

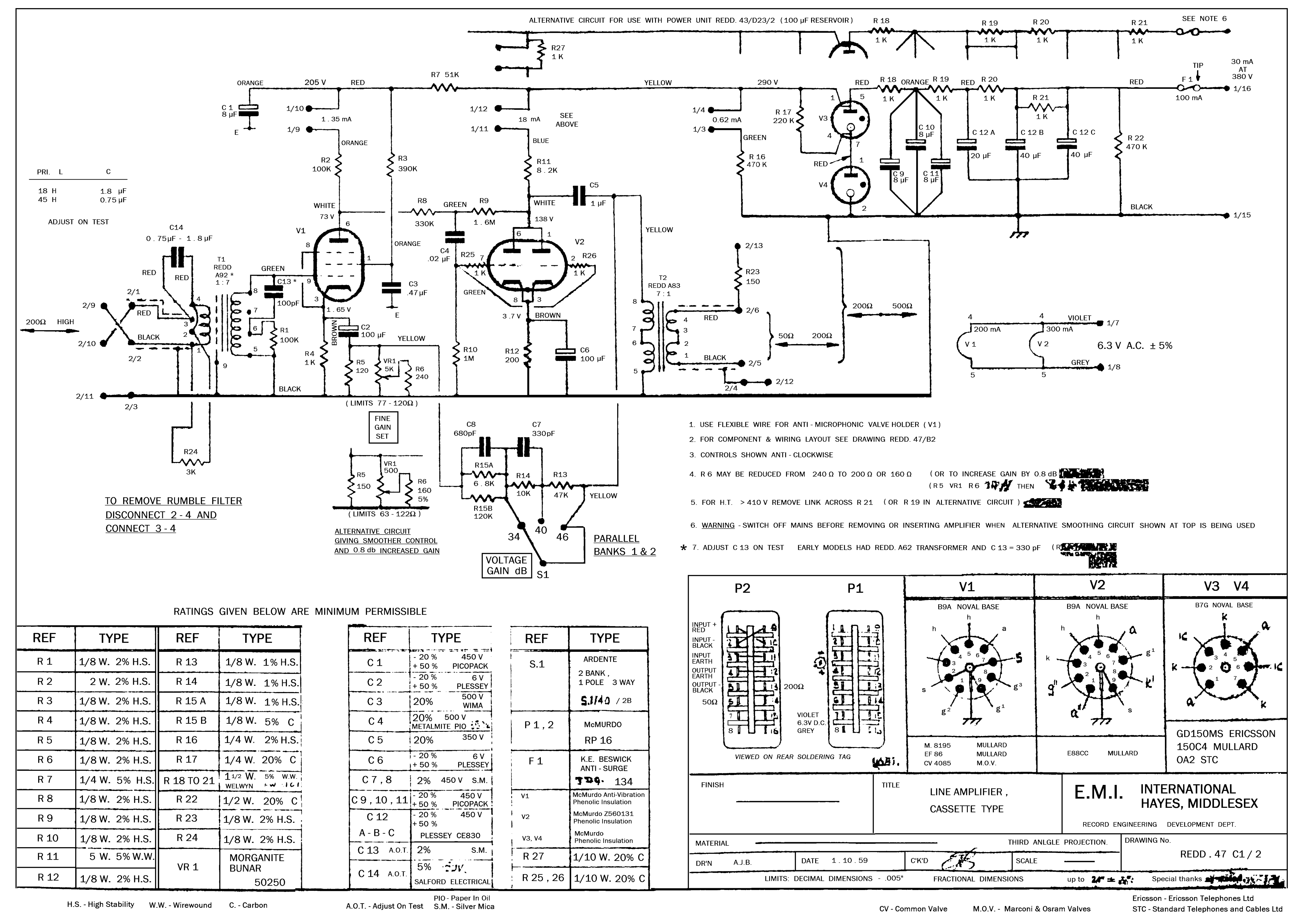
Although a stiffener bar has been added to the front panel, undue force should not be used when fixing an amplifier to the rack frame. Press the amplifier firmly home, until it comes up against the back stops, but use only light finger pressure on the knurled securing knob. <u>The coin slot should be used only to unscrew</u> the rod if it has become tight.

LAP/AV.

August, 1961.



ALTERNATIVE CIRCUIT FOR USE WITH POWER UNIT
ORANGE 205V. RED
YELLOW
290V
RED
47 51K
R37 1K
R1 100K
V1
V2
V4
T1 REDD.
T2 REDD.483
200Ω HIGH
2/9
2/10
2/11
2/12
2/13
2/5
2/6
7/2
C14 0.75-1.8
C1 8
C3 .47
C5 1
C6 100
C7 330pF
C8 680pF
C10 8
C11 8
C12A 20
C12B 40
C12C 40
R4 1K
R5 150
R6 150
R10 1M
R11 8.2K
R12 200
R13 47K
R14 12K
R15A 6.8K
R15B 120K
R16 470K
R17 22.0K
R18 1K
R19 1K
R20 1K
R21 1K
R22 470K
R23 15Ω
R24 3K
30mA AT 380V
100mA
F1
GREEN
BLUE
WHITE
BLACK
200Ω 100Ω
50Ω 200Ω
6.3V. ±2.5%
S1
TO REMOVE "RUMBLE" FILTER
DISCONNECT 2-4 AND
CONNECT 3-4
ALTERNATIVE CIRCUIT
GIVING SHELVING CONTROL
VOLTAGE GAIN dB
PARALLEL BANKS
4. R.G. MAY BE REDUCED 240Ω TO 200Ω
5. FOR H.T. 410V, REMOVE LINK ACROSS R.21
6. WARNING - SWITCH OFF MAINS BEFORE REMOVING
7. ADJUST C14 ON TEST
1. USE FLEXIBLE WIRE FOR ANTI-MICROPHONIC VALVEHOLDER
2. FOR COMPONENT & WIRING LAYOUT SEE DRG. REDD.47
3. CONTROLS SHOWN ANTI-CLOCKWISE
RATINGS GIVEN BELOW ARE MINIMUM PERMISSIBLE
REF.
TYPE
P2
P1
V1
V2
M.8195 MULLARD
EF 86 MULLARD
E88CC MULLARD
150C4
OA2
TITLE
LINE AMPLIFIER,
CASSETTE TYPE
E.M.I. INTERNATIONAL
HAYES, MIDDLESEX
RECORD ENGINEERING DEVELOPMENT
FINISH
MATERIAL
THIRD ANGLE PROJECTION
DRAWING No.
REDD.47
DATE
CKD
SCALE



1. USE FLEXIBLE WIRE FOR ANTI - MICROPHONIC VALVE HOLDER (V1)
2. FOR COMPONENT & WIRING LAYOUT SEE DRAWING REDD. 47/B2
3. CONTROLS SHOWN ANTI - CLOCKWISE
4. R 6 MAY BE REDUCED FROM 240 Ω TO 200 Ω OR 160 Ω (OR TO INCREASE GAIN BY 0.8 dB [redacted] (R 5 VR1 R 6 [redacted] THEN [redacted]
5. FOR H.T. > 410 V REMOVE LINK ACROSS R 21 (OR R 19 IN ALTERNATIVE CIRCUIT) [redacted]
6. WARNING - SWITCH OFF MAINS BEFORE REMOVING OR INSERTING AMPLIFIER WHEN ALTERNATIVE SMOOTHING CIRCUIT SHOWN AT TOP IS BEING USED
* 7. ADJUST C 13 ON TEST EARLY MODELS HAD REDD. A62 TRANSFORMER AND C 13 = 330 pF (R[redacted]

RATINGS GIVEN BELOW ARE MINIMUM PERMISSIBLE

REF	TYPE	REF	TYPE
R 1	1/8 W. 2% H.S.	R 13	1/8 W. 1% H.S.
R 2	2 W. 2% H.S.	R 14	1/8 W. 1% H.S.
R 3	1/8 W. 2% H.S.	R 15 A	1/8 W. 1% H.S.
R 4	1/8 W. 2% H.S.	R 15 B	1/8 W. 5% C
R 5	1/8 W. 2% H.S.	R 16	1/4 W. 2% H.S.
R 6	1/8 W. 2% H.S.	R 17	1/4 W. 20% C
R 7	1/4 W. 5% H.S.	R 18 TO 21	1 1/2 W. 5% W.W. WELWYN
R 8	1/8 W. 2% H.S.	R 22	1/2 W. 20% C
R 9	1/8 W. 2% H.S.	R 23	1/8 W. 2% H.S.
R 10	1/8 W. 2% H.S.	R 24	1/8 W. 2% H.S.
R 11	5 W. 5% W.W.	VR 1	MORGANITE BUNAR 50250
R 12	1/8 W. 2% H.S.		

REF	TYPE
C 1	- 20 % + 50 % 450 V PICOPACK
C 2	- 20 % + 50 % 6 V PLESSEY
C 3	20% 500 V WIMA
C 4	20% 500 V METALMITE PIO
C 5	20% 350 V
C 6	- 20 % + 50 % 6 V PLESSEY
C 7 , 8	2% 450 V S.M.
C 9 , 10 , 11	- 20 % + 50 % 450 V PICOPACK
C 12 A - B - C	- 20 % + 50 % 450 V PLESSEY CE830
C 13 A.O.T.	2% S.M.
C 14 A.O.T.	5% SALFORD ELECTRICAL

REF	TYPE
S.1	ARDENTE 2 BANK , 1 POLE 3 WAY S.1/40 / 2B
P 1 , 2	McMURDO RP 16
F 1	K.E. BESWICK ANTI - SURGE TDQ. 134
V1	McMurdo Anti-Vibration Phenolic Insulation
V2	McMurdo Z560131 Phenolic Insulation
V3, V4	McMurdo Phenolic Insulation
R 27	1/10 W. 20% C
R 25 , 26	1/10 W. 20% C

H.S. - High Stability W.W. - Wirewound C. - Carbon A.O.T. - Adjust On Test PIO - Paper In Oil S.M. - Silver Mica CV - Common Valve M.O.V. - Marconi & Osram Valves Ericsson - Ericsson Telephones Ltd STC - Standard Telephones and Cables Ltd

FINISH	TITLE LINE AMPLIFIER , CASSETTE TYPE	E.M.I. INTERNATIONAL HAYES, MIDDLESEX RECORD ENGINEERING DEVELOPMENT DEPT.	
MATERIAL		THIRD ANLGLE PROJECTION.	DRAWING No. REDD . 47 C1 / 2
DR'N A.J.B.	DATE 1 . 10 . 59	C'K'D	SCALE
LIMITS: DECIMAL DIMENSIONS - .005"	FRACTIONAL DIMENSIONS	up to [redacted]	Special thanks [redacted]